Multiple scattering of light by nanoparticles in Er3+-doped optical fibers

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TOPIC**: Photonic Crystal Materials and Devices** (Conference EPE103)

PRESENTATION PREFERENCE: Oral presentation

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Abstract

The presence of scatterers, for long, had been considered detrimental for the growth of photonic devices. Hence, a great care is taken during the fabrication of fibers and optical devices to avoid scatterers, which may lead to a loss of signal strength and efficiency of the device. However, random scatterers have become a topic of immense research in the studies for random lasing and photon localization [1,2]. It has been shown that scattering can also be constructive for lasing. Furthermore, its ease of fabrication and the idea of obtaining a mirrorless laser have driven the research far ahead.

Here, we report on the effect of scatterers on erbium emission properties in fibers containing nanoparticles. These erbium-doped silica fibers were incorporated with calcium or strontium nanoparticles [3] of about 100 nm diameter giving rise to strong scattering. Various studies were carried out on these fibers to infer the effect of scattering arising from the nanometric particles distributed randomly along its core. Photoluminescence measurements were performed as a function of length of the fiber, the excitation wavelength and the laser excitation power. We would also discuss the effect of self-absorption of Er^{3+} luminescence in these fibers in the presence and absence of scatterers. Finally, we investigate the possibility of observing random lasing in these fibers.

[1] Diederik S. Wiersma, "The physics and applications of random lasers," Nature Physics 4 (2008) 359-367.

[2] Ad Lagendijk, Bart van Tiggelen, and Diederik S. Wiersma, "Fifty years of Anderson localization," Phys. Today 62, (2009) 24-29.

[3] Wilfried Blanc, Bernard Dussardier, Gérard Monnom, Romain Peretti, Anne-Marie Jurdyc, Bernard Jacquier, Marie Foret, and Ann Roberts, "Erbium emission properties in nanostructured fibers," Appl. Optics 48 (2009) G119-G124.